

# Four new species of coral- and rock-boring polychaetes *Daylithos* (Annelida, Flabelligeridae) from the Pacific Ocean

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<https://zoobank.org/D39CCABA-E7E0-4D64-BCC8-54371D9BE612>

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## Abstract

Four new species of *Daylithos* (Flabelligeridae, Annelida) are described, based on specimens collected from rocks and corals of Japan and Malaysia. *Daylithos*, contains one species, *D. parmatus*, currently reported from Japan. However, the specimens described in previous reports were unable to be located and thus deemed lost. Therefore, it was unclear whether the specimens described as *D. parmatus* in those studies were, indeed, the species. In Malaysia, *D. parmatus* has also been known as popular species from corals. The specimens collected from Langkawi (Malaysia) showed clearly different characters from *D. parmatus* and other congeners. In this study, we describe four new species, *Daylithos japonicus*, *D. amamiensis*, *D. sugashimaensis* and *D. langkawiensis*, based on newly-collected specimens from several part of Japan and Malaysia. These new species can be discriminated from other congeners by body colour, presence of eyes, shape of dorsal shield, length of caruncle and arrangement of neurochaetae. We have also provided mitochondrial cytochrome *c* oxidase subunit I sequences of the new species.

## Key Words

Flabelligeridae, Pacific Ocean, Polychaeta, polychaetes, taxonomy

## Introduction

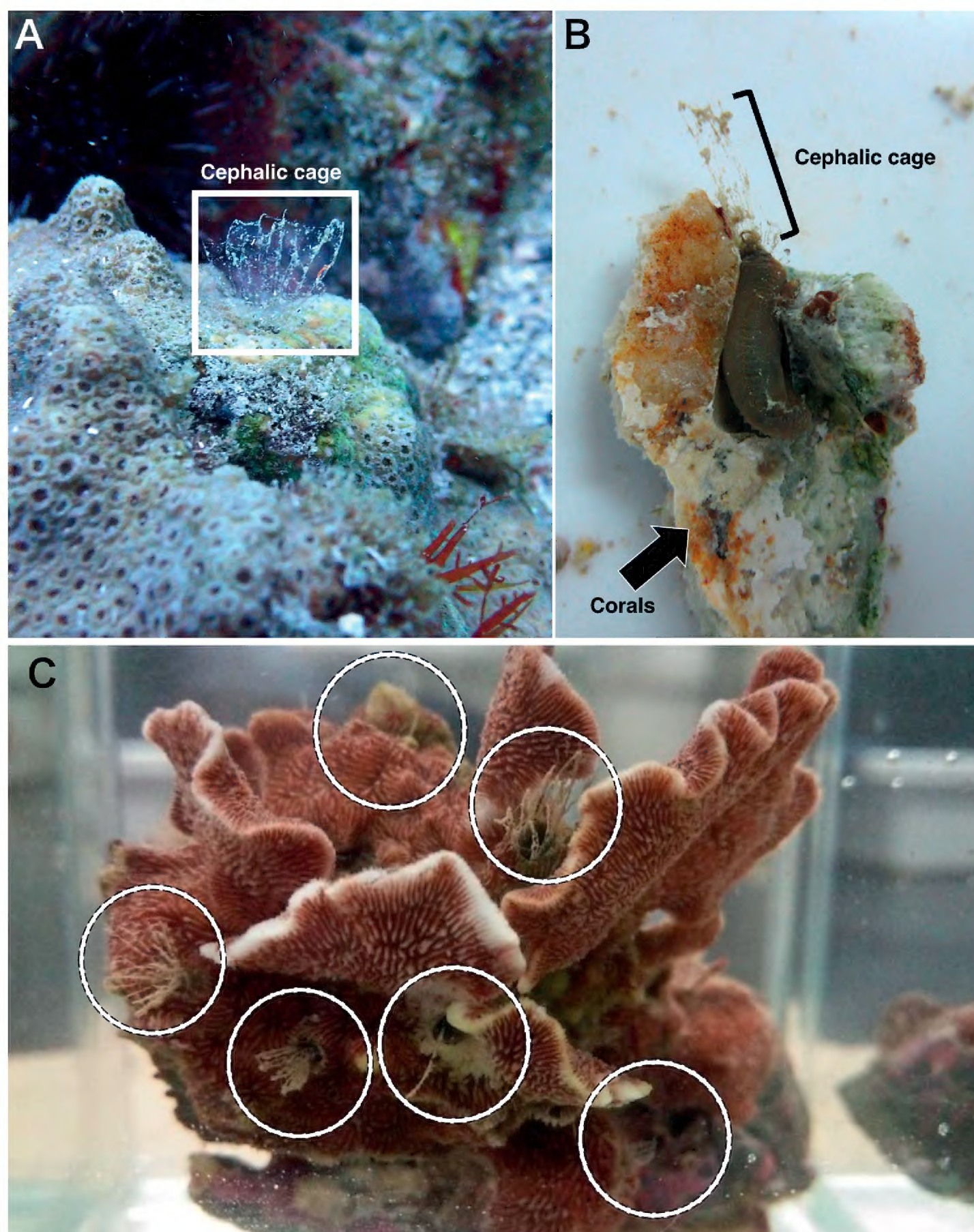
The members of the genus *Daylithos* Salazar-Vallejo, 2012, are flabelligerid species which live by boring into rocks and corals (Salazar-Vallejo 2012, 2019) (Fig. 1A, B). Their heads have a hard, sandy part called the dorsal shield which is as wide as the tunnel and functions like a lid (Amor 1994). As they live in rocks and corals, they are traded as a by-product of the coral trade in areas beyond their normal distribution by aquarium shops (Jimi 2020) (Fig. 1C). It is important to understand their exact diversity and habitat to manage and prevent the introduction of alien species to non-native areas. A recent study by Salazar-Vallejo (2012, 2019) concluded that *Daylithos* consists of six species.

*Daylithos parmatus* (Grube, 1877) is the only species of the genus known from Japanese waters (Imajima

and Hartman 1964; Hayashi et al. 1982; Imajima 1982; Iwase et al. 1990; Uchida 1992; Imajima 2006, 2011). The species *D. parmatus* had been reported from all over the world before the revision by Salazar-Vallejo (2012). He confirmed that *D. parmatus* is restricted to the tropical Western Pacific Ocean and indicated that specimens recorded elsewhere represent other species. *Daylithos parmatus* has been also recorded from several sites in Malaysian waters, being the only species of boring flabelligerids recorded from this country (Salazar-Vallejo 2012).

In the present study, we collected and taxonomically re-examined the boring flabelligerids from Japan and Malaysia. By comparing their morphologies, we discovered four new species and found no material of *D. parmatus* from Japan.





**Figure 1.** *Daylithos* spp. (A, B. *D. japonicus* sp. nov.; C. Unidentified *Daylithos* sp.) inside corals. A. In situ observation of a cephalic cage with mucus from corals, Kochi, Japan; B. Cross-sectional view of corals and burrow; C. Coral colony sold in an aquarium shop. White circles indicate flabelligerids.

## Materials and methods

Flabelligerids were collected from rocks or corals retrieved by SCUBA or gill net (= piece of mudstones caught on nets). After taking photographs of live material, specimens were fixed in 70% ethanol and observed with stereomicroscopes (Nikon SMZ800N). Chaetal features were observed in compound microscopes (Nikon Ni). The specimens examined were deposited in the National Museum of Nature and Science, Tsukuba (NSMT).

DNA extraction, sequencing, alignment and removal of ambiguous positions were carried out following the methods detailed in Jimi et al. (2021) to obtain sequences of the mitochondrial *COI* gene. Branchiae were used for DNA extraction. The newly-obtained sequences were deposited in GenBank (OQ352240–OQ352243).

## Results

### Systematics

#### Genus *Daylithos* Salazar-Vallejo, 2012

[New Japanese name: Ana-hori-habouki-zoku]

#### *Daylithos japonicus* sp. nov.

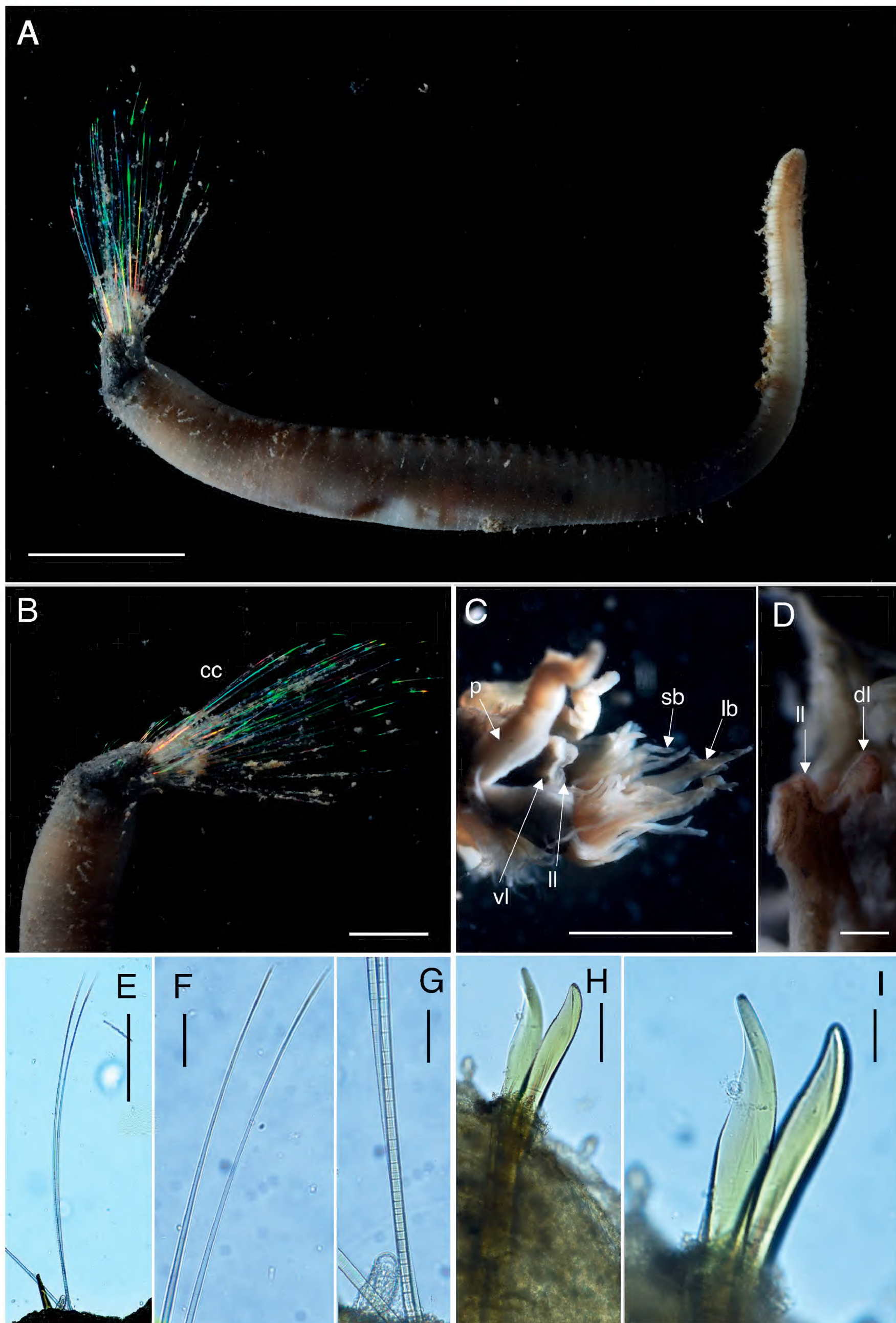
<https://zoobank.org/48836DCB-C794-40AD-9512-A4DEF26BB4CB>

Fig. 2

Japanese name: Minami-habouki

**Type material.** *Holotype* (NSMT-Pol H-903): complete, collected in front of Kuroshio Biological Research Institute (32.7787°N, 132.7326°E), Kochi, 10 m depth,





**Figure 2.** *Daylithos japonicus* sp. nov. Holotype (NSMT-Pol H-903). **A.** Whole body, lateral view; **B.** Anterior end, lateral view; **C.** Prostomium, frontal view; **D.** Prostomium, lateral view; **E.** Notochaetae, chaetiger 12; **F.** Distal part of notochaetae; **G.** Basal part of notochaetae; **H.** Neurohook, chaetiger 12. Scale bars: 5 mm (**A**); 2.5 mm (**B**); 0.5 mm (**C**); 0.1 mm (**D**); 200 µm (**E**); 100 µm (**F**); 100 µm (**G**); 200 µm (**H**). Abbreviations: cc, cephalic cage; lb, large branchia; sb, small branchia; p, palp; dl, dorsal lip; ll, lateral lip; vl, ventral lip.



SCUBA, Naoto Jimi, 12 Oct 2017. Paratype (NSMT-Pol P-904): six specimens, complete, collected with holotype, 12 Oct 2017. **Paratypes** (NSMT-Pol P-905): 10 specimens, complete, collected from Hakamagoshi (31.5907°N, 130.5922°E), Kagoshima, 5–15 m depth, by SCUBA, Naoto Jimi, 17 Nov 2016. **Paratypes** (NSMT-Pol P-906): three specimens, complete, collected from Shirahama (33.6918°N, 135.3360°E), Wakayama, 5–10 m depth, by SCUBA, Naoto Jimi, 25 Aug 2016.

**Description (based on holotype).** Body 40 mm in total length (17–40 mm in paratypes), 4 mm in width (2–5 mm in paratypes), 94 chaetigers (70–91 chaetigers in paratypes), greyish, cylindrical, tapering posteriorly into flat cauda (Fig. 2A). Tunic thin, without sediment particles, greyish. Dorsal shield flat, without depression or projection (Fig. 2B). Body papillae minute, distally rounded, arranged in two rows per segment, anterior row with more papillae. Gonopodial lobes not seen. Neuropodial base of chaetiger 5 slightly swollen.

Prostomium oval. Eyes present, blackish. Caruncle slightly exceeding the branchial plate margin. Dorsal and lateral lips present (Fig. 2C, D); ventral lip smaller than dorsal and lateral lips. Palps thicker than branchiae. Branchiae in two lateral groups, each with 20 filaments. Longest branchiae in inner rows, about half as long as palps, decreasing in length towards lateral margins (Fig. 2C). Nephridial lobes not seen.

Cephalic cage chaetae about 3/8 body length, four times as long as body width (Fig. 2B). Chaetiger 1–2 comprising cephalic cage; chaetiger 1 with 8 notochaetae and 7 neurochaetae per side; chaetiger 2 with 7 notochaetae and 7 neurochaetae per side. Chaetiger 1 1.1 times longer than chaetiger 2. Chaetae of chaetiger 3 two times longer than the following ones. Chaetal transition from cephalic cage to body chaetae abrupt.

Notopodia poorly developed, lateral; neuropodia ventrolateral in median body. Notopodia and neuropodia widely separated. Parapodial lobes absent. Notochaetae multi-articulated capillaries, transparent, 1/4 maximum body width, 3–4 per bundle, with about 90 articles (Fig. 2E); articles medium-sized distally (20 times as long as wide) (Fig. 2F), short medially and basally (two times as long as wide) (Fig. 2G). Neurochaetae multi-articulated, aristate capillaries in chaetigers 1 to 7, 3 per bundle. Neurohooks present from chaetiger 8 (Fig. 2H), arranged in short transverse rows, golden, 1–4 per ramus in anterior chaetigers, 5–8 in posterior chaetigers, subdistally wider, tip slightly curved. 6–7 articles (two times as long as wide).

Posterior end depressed; pygidium with anus terminal, anal cirri absent.

Oocytes inside middle part of body, brackish in ethanol.

**Etymology.** The specific name *japonicus* is a Latin adjective, referring to the occurrence of the new species in Japan.

**Distribution.** Southern Japan, shallow subtidal areas; 3–15 m depth; in burrows within corals. Corals as hosts of the new species are mainly found from Faviidae.

**Remarks.** *Daylithos japonicus* sp. nov. resembles *D. iris* (Michaelsen, 1892) in having the greyish body in fixed material, 5–8 neurohooks on far posterior

chaetigers and the flat dorsal shield (Michaelsen 1892; Salazar-Vallejo 2012). These species differ because, in *D. japonicus*, neurohooks are present from chaetiger 8 onwards, but, in *D. iris*, they start in chaetiger 10. The cephalic cage of *D. japonicus* is 3/8 of body length, while *D. iris* is 1/8 of body length. Eyes are present in the new species, while absent in *D. iris*. On the other hand, *D. japonicus* resembles *D. parmatus* in having a greyish body and many neurohooks on far posterior chaetigers; however, in *D. japonicus*, the dorsal shield is flat and there are 5–8 neurochaetae in posterior chaetigers, whereas in *D. parmatus*, the dorsal shield is cleft and has 4–7 neurochaetae in posterior chaetigers.

Japanese *Daylithos*, which is called “Minamihabouki” has been recorded as *D. parmatus* in Japan (Fauvel 1936; Imajima and Hartman 1964; Uchida 1992). In this study, it turned out that *D. parmatus* reported from Japan is a misidentification and actually is *D. japonicus*, the present new species (see Discussion).

### *Daylithos amamiensis* sp. nov.

<https://zoobank.org/7E826790-040F-44BD-8F7D-45ED8352D7F5>

Fig. 3

Japanese name: Amami-habouki

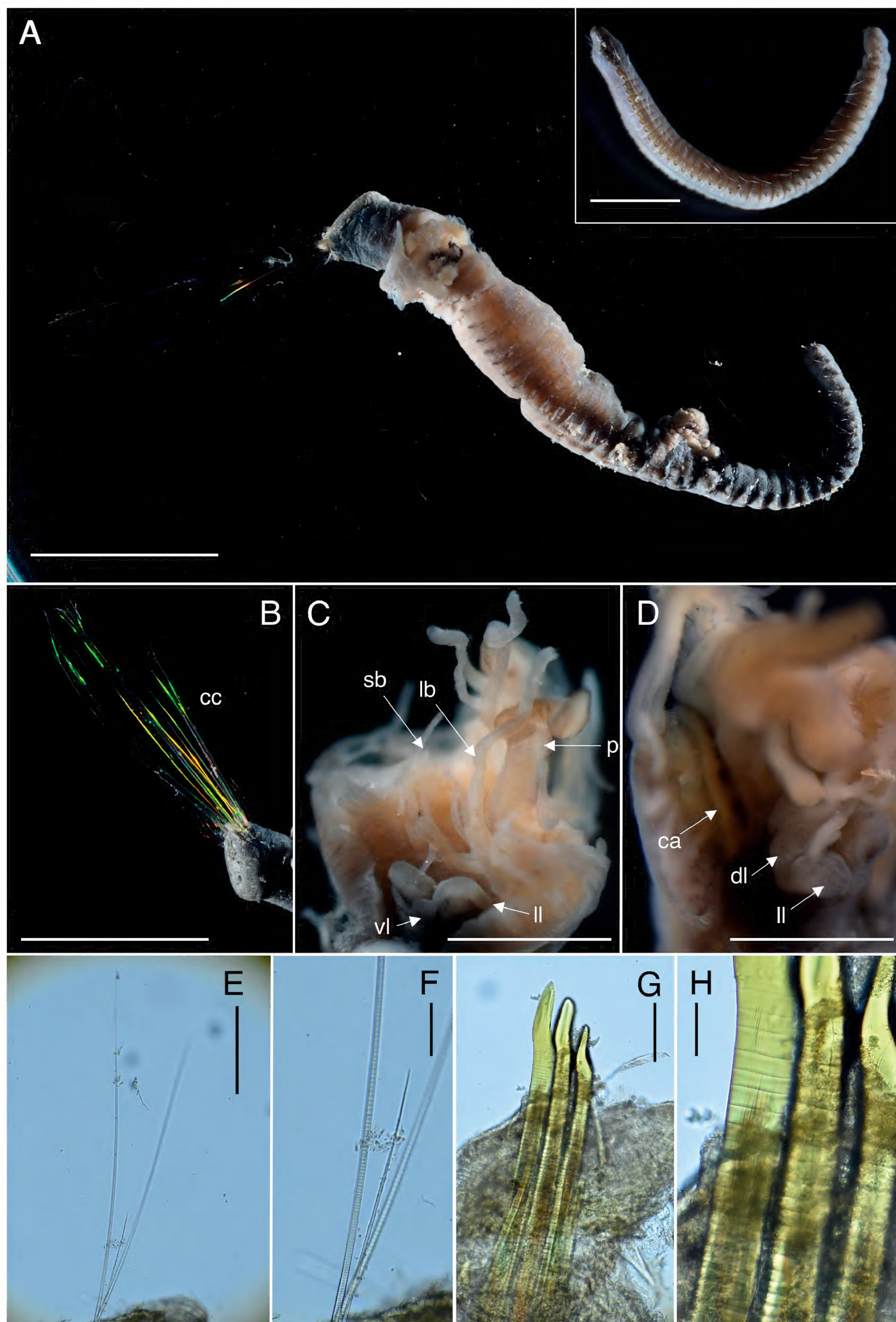
**Type material.** **Holotype** (NSMT-Pol H-907): collected from Shirahama, Amami Oshima (28.1970°N, 129.2699°E), 5 m depth, SCUBA, Naoto Jimi, 15 Nov 2016. **Paratype** (NSMT-Pol P-908): one specimen, middle chaetigers lost, collected from same locality as holotype, 15 Nov 2016.

**Description (based on holotype).** Body 30 mm in total length (24 mm in paratype), 3 mm in width (3 mm in paratype), 47 chaetigers (posterior chaetigers lost) (67 chaetigers in paratype), greyish, cylindrical (Fig. 3A). Body tapering posteriorly into flat cauda (paratype) (Fig. 3A). Tunic thin, without sediment particles, blackish. Dorsal shield flat, without depression or projection (Fig. 3B). Body papillae minute, distally rounded, arranged in two rows per segment; anterior row papillae longer than posterior. Gonopodial lobes absent. Neuroparapodial base of chaetiger 5 slightly swollen.

Prostomium oval. Eyes present, blackish. Caruncle slightly exceeding the branchial plate margin, with black pigments. Dorsal and lateral lips present (Fig. 3C, D); ventral lip smaller than dorsal and lateral lips. Palps thicker than branchiae. Branchiae in two lateral groups, each with 35 filaments. Longest branchiae in inner rows, about half as long as palps, decreasing in length towards the lateral margins (Fig. 3C). Nephridial lobes not seen. Larger branchiae three times wider than smaller branchiae.

Cephalic cage chaetae about three times longer than body width (Fig. 3A). Chaetiger 1–2 comprising cephalic cage (Fig. 3B); chaetiger 1 with 7 notochaetae and 8 neurochaetae per side; chaetiger 2 with 5 notochaetae and 6 neurochaetae per side. Chaetiger 1 1.5 times longer than chaetigers 2. Chaetae of chaetiger 3 two times longer than the following ones. Chaetal transition from cephalic cage to body chaetae abrupt.





**Figure 3.** *Daylithos amamiensis* sp. nov. Holotype (NSMT-Pol H-907). **A.** Whole body, lateral view (insert: posterior end of paratype); **B.** Anterior end, lateral view; **C** Prostomium, frontal view; **D.** Prostomium, lateral view; **E.** Notochaetae, chaetiger 12; **F.** Basal part of notochaeta; **G.** Neurohook, chaetiger 12; **H.** Middle part of neurohook. Scale bars: 10 mm (**A**, **B**); 2.5 mm (**A** (insert)); 2 mm (**C**, **D**); 200  $\mu$ m (**E**); 100  $\mu$ m (**F**); 200  $\mu$ m (**G**); 100  $\mu$ m (**H**). Abbreviations: cc, cephalic cage; ca, caruncle; lb, large branchia; sb, small branchia; p, palp; dl, dorsal lip; ll, lateral lip; vl, ventral lip.



Notopodia poorly developed, lateral; neuropodia ventrolateral in median body. Notopodia and neuropodia widely separated. Parapodial lobes absent. Notochaetae multi-articulated capillaries (Fig. 3E), transparent, 1/4 maximum body width, 2–3 per bundle, with about 110 articles; articles medium-sized distally (12 times as long as wide), short medially and basally (1/2 times as long as wide) (Fig. 3F). Neurochaetae multi-articulated aristate capillaries in chaetigers 1 to 6, 3 per bundle. Neurohooks present in chaetiger 7, arranged in short transverse rows, golden colour (Fig. 3G, H), 1–4 per ramus in anterior chaetigers, 4–6 in posterior chaetigers, curved. About 30 anchylosed articles in larger hooks.

Posterior end depressed; pygidium with anus terminal, without anal cirri.

Oocytes inside middle part of body, blackish in ethanol.

**Etymology.** This species is named after the type locality, Amami Oshima.

**Distribution.** This species is only known from the type locality, 5 m in depth, Shirahama, Amami-Oshima, Japan; found in burrows within corals (Acroporidae).

**Remarks.** *Daylithos amamiensis* sp. nov. resembles *D. iris* (Michaelsen, 1892) and *D. japonicus* sp. nov. in having the greyish body in fixed material, 4–6 neurohooks on far posterior chaetigers and the flat dorsal shield. While neurohooks of *D. amamiensis* are present from chaetiger 7, those of *D. iris* are from chaetiger 10; and in *D. japonicus*, are from chaetiger 8. Eyes are present in *D. amamiensis*, but absent in *D. iris*. Further, in *D. amamiensis*, the body papillae in the anterior row are longer than posterior ones; whereas those in *D. japonicus* are similar size to posterior ones.

#### *Daylithos sugashimaensis* sp. nov.

<https://zoobank.org/9A4DB231-5428-4B9B-B090-348F8F68CC51>

Fig. 4

Japanese name: Sugashima-habouki

**Type material.** *Holotype* (NSMT-Pol H-909): complete, off Sugashima Island (34.4951°N, 136.9112°E), 20 m depth, collected by gillnet, Naoto Jimi, 21 Apr 2022.

**Paratypes** (NSMT-Pol P-910): two specimens, complete, collected with holotype, 21 Apr 2022. **Paratypes** (NSMT-Pol P-911): three specimens, complete, off Sugashima Island (34.4946°N, 136.9161°E), 75 m depth, collected by gillnet, Naoto Jimi, 27 Apr 2022. **Paratypes** (NSMT-Pol P-912): one broken specimen (identified with DNA sequence), Hikottoland Marine Beach, Yamaguchi (33.9451°N, 130.8974°E), intertidal, collected by hand, Teppei Kushimoto, 27 Apr 2022.

**Description (based on holotype).** Body 30 mm in total length (14–60 mm in paratypes), 3 mm in width (1–4 mm in paratypes), 84 chaetigers (70–106 chaetigers in paratypes), greyish, cylindrical, tapering posteriorly into flat cauda (Fig. 4A). Tunic thin, without sediment particles, pale. Dorsal shield flat, without depression or projection (Fig. 4B). Body papillae minute, distally rounded,

arranged in two rows per segment, papillae of anterior row similar size to posterior row. Gonopodial lobes not seen. Neuropodial base of chaetiger 5 slightly swollen.

Prostomium oval. Eyes present, blackish. Caruncle slightly exceeding the branchial plate margin. Dorsal and lateral lips present (Fig. 4C, D); ventral lip smaller than dorsal and lateral lips. Palps thicker than branchiae. Branchiae in two lateral groups, each with 25 filaments. Longest branchiae in inner rows, about 2/3 as long as palps, decreasing in length towards lateral margins. Nephridial lobes not seen. Large branchiae two times wider than smaller branchiae.

Cephalic cage chaetae about 1/3 body length, four times as long as body width (Fig. 4A, B). Chaetiger 1–2 comprising cephalic cage; chaetiger 1 with 10 notochaetae and 10 neurochaetae per side; chaetiger 2 with 8 notochaetae and 8 neurochaetae per side. Chaetiger 1 1.5 times longer than chaetiger 2. Chaetae of chaetiger 3 four times longer than the following ones, not contributing to the cephalic cage. Chaetal transition from cephalic cage to body chaetae abrupt.

Notopodia poorly developed, lateral; neuropodia ventrolateral in median body. Notopodia and neuropodia widely separated. Parapodial lobes absent. Notochaetae multi-articulated capillaries, transparent, 1/4 maximum body width, 2–4 per bundle, with about 90 articles (Fig. 4E); articles medium-sized distally (30 times as long as wide), short medially and basally (1/2 times as long as wide) (Fig. 4F). Neurochaetae multi-articulated aristate capillaries in chaetigers 1 to 8, 2–5 per bundle. Neurohooks present in chaetiger 9, arranged in short transverse rows, golden (Fig. 4G, H), 1–2 large barely falcate anchylosed hooks with very small anchylosed 2–3 hooks per ramus in anterior chaetigers, 2–4 in posterior chaetigers, curved. 30–40 anchylosed articles in larger hooks, 40–50 anchylosed articles in smaller hooks.

Posterior end depressed; pygidium with anus terminal, anal cirri absent.

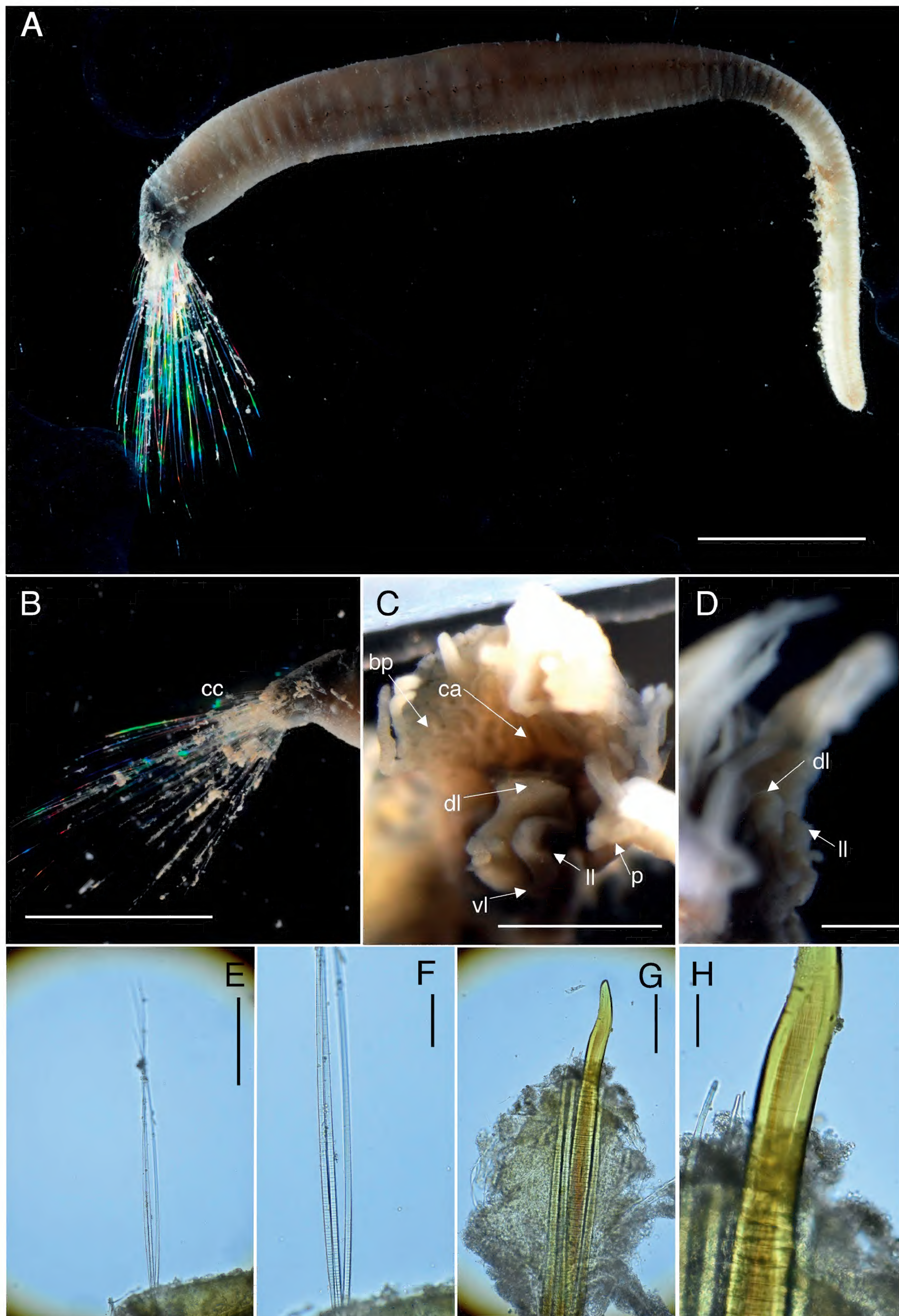
Oocytes inside middle part of body, blackish in ethanol.

**Etymology.** this species is named after the type locality (Sugashima Island).

**Distribution.** intertidal to subtidal area of South Japan; 0–75 m depth; inside of rocks (mudstone).

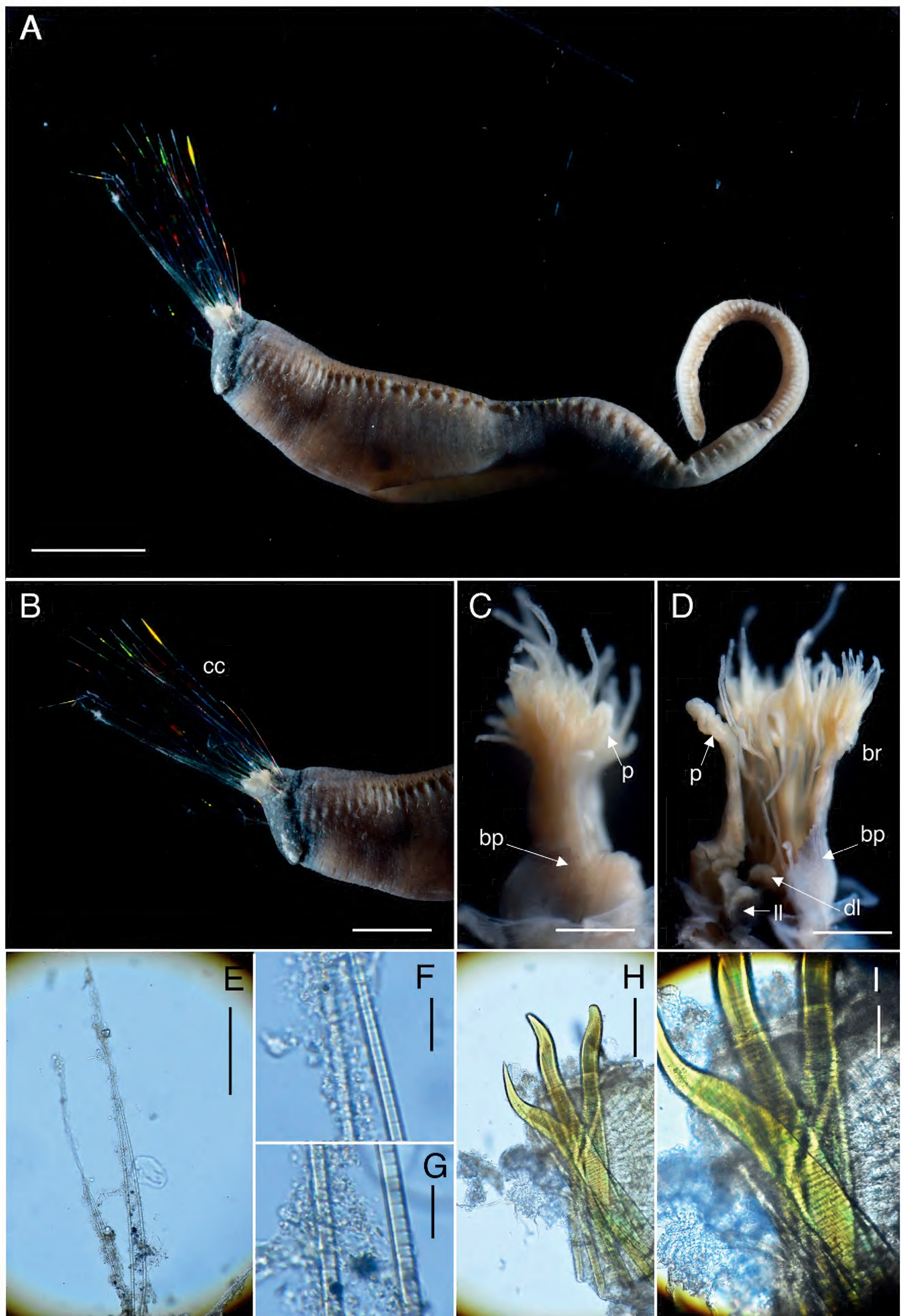
**Remarks.** *Daylithos sugashimaensis* sp. nov. resembles *D. amorae* Salazar-Vallejo, 2012 and *D. nudus* (Caullery, 1944) in having the greyish body in fixed material and 2–4 neurohooks in posterior chaetigers. However, *D. sugashimaensis* can be discriminated from the two other species by having two rows of body papillae as opposed to one row, neurohooks present from chaetiger 9 and dorsal shield without posterior projection. While neurohooks of *D. sugashimaensis* are present from chaetiger 9, those of *D. amorae* are from chaetiger 7; and in *D. nudus*, are from chaetiger 6. Body papillae of *D. sugashimaensis* and *D. nudus* are two rows, but of *D. amorae* are one row. While the dorsal shields of *D. nudus* and *D. amorae* are with posterior projections, *D. sugashimaensis* is without posterior projection.





**Figure 4.** *Daylithos sugashimaensis* sp. nov. Holotype (NSMT-Pol H-909). **A.** Whole body, lateral view; **B.** Anterior end, lateral view; **C.** Prostomium, frontal view; **D.** Prostomium, lateral view; **E.** Notochaetae, chaetiger 12; **F.** Basal part of notochaetae; **G.** Neurohook, chaetiger 12; **H.** Middle part of neurohook. Scale bars: 5 mm (**A**, **B**); 2 mm (**C**); 1 mm (**D**); 200 μm (**D**); 100 μm (**E**); 200 μm (**F**); 100 μm (**G**). Abbreviations: cc, cephalic cage; ca, caruncle; p, palp; dl, dorsal lip; ll, lateral lip; vl, ventral lip.





**Figure 5.** *Daylithos langkawiensis* sp. nov. Holotype (USMCRC-Pol001). **A.** Whole body, lateral view; **B.** Anterior end, lateral view; **C.** Prostomium, lateral view, covered by branchial plate; **D.** Prostomium, frontal view; **E.** Notochaetae, chaetiger 12; **F.** Distal part of notochaetae; **G.** Basal part of notochaetae; **H.** Neurohook, chaetiger 12; **I.** Middle part of neurohook. 5 mm (**A**, **B**); 1 mm (**C**, **D**); 200  $\mu$ m (**E**); 100  $\mu$ m (**F**); 200  $\mu$ m (**G**); 100  $\mu$ m (**H**); 50  $\mu$ m (**I**). Abbreviations: bp, branchial plate; br, branchiae; p, palp; dl, dorsal lip; ll, lateral lip.



***Daylithos langkawiensis* sp. nov.**

<https://zoobank.org/81A08A40-19BB-4151-9F1A-CA8A4EF8AE69>

Fig. 5

**Material examined.** *Holotype* (USMCRC-Pol001): complete, south coast of Pulau Dangli, Langkawi, Malaysia (6.4473°N, 99.7774°E), 3–5 m depth, collected by SCUBA, Naoto Jimi, 11 Mar 2018. *Paratypes* (USMCRC-Pol002): four specimens, complete, collected from same locality as holotype, 11 Mar 2018.

**Description.** Body 38 mm in total length (30–40 mm in paratypes), 4 mm in width (3–5 mm in width), 85 chaetigers (54–80 chaetigers in paratypes), greyish, cylindrical, tapering posteriorly into flat cauda (Fig. 5A). Tunic thin, without sediment particles, pale. Dorsal shield flat, without depression or projection (Fig. 5B). Body papillae minute, distally rounded, arranged in two rows per segment, posterior row papillae longer than anterior. Gonopodial lobes not seen. Neuropodial base of chaetiger 5 slightly developed.

Prostomium oval, completely covered by branchial plate (Fig. 5C). Eyes present, blackish. Caruncle slightly exceeding the branchial plate margin. Dorsal and lateral lips present; ventral lip smaller than dorsal and lateral lips (Fig. 5D). Palps thicker than branchiae (Fig. 5C, D). Branchiae in two lateral groups, each with 30 filaments. Longest branchiae in inner rows slightly longer than outer rows. Nephridial lobes not seen.

Cephalic cage chaetae about 2/7 body length, four times as long as body width (Fig. 5A, B). Chaetiger 1–2 comprising cephalic cage; chaetiger 1 with 8 notochaetae and 10 neurochaetae per side; chaetiger 2 with 6 notochaetae and 8 neurochaetae per side. Chaetiger 1 two times longer than chaetiger 2. Chaetae of chaetiger 3 three times longer than the following ones. Chaetal transition from cephalic cage to body chaetae abrupt.

Notopodia poorly developed, lateral; neuropodia ventrolateral in median body. Notopodia and neuropodia widely separated. Parapodial lobes absent. Notochaetae multi-articulated capillaries, transparent, 1/5 maximum body width, 2–4 per bundle, with approximately 90 articles (Fig. 5E); articles medium-sized distally (20 times as long as wide) (Fig. 5F), short medially and basally (2/3 times as long as wide) (Fig. 5G). Neurochaetae multi-articulated aristate capillaries in chaetigers 1 to 7, aristate capillaries, 3 per bundle. Neurohooks present in chaetiger 8, arranged in short transverse rows, golden (Fig. 5H, I), 2–4 per ramus in anterior chaetigers, 2–6 in posterior chaetigers, curved, articles very short, anchylosed.

Posterior end depressed; pygidium with anus terminal, anal cirri absent.

Oocytes inside middle part of body, blackish in ethanol.

**Etymology.** this species is named after the type locality, Langkawi.

**Distribution.** shallow subtidal area of Langkawi Island, Malaysia; 3–5 m depth;

Corals as hosts of the new species are not restricted to specific species (mainly found from Faviidae).

**Remarks.** *Daylithos langkawiensis* sp. nov. resembles *D. iris* (Michaelsen, 1892), *D. japonicus* sp. nov. and *D. amamiensis* sp. nov. in having a greyish body in fixed material, 2–6 neurohooks on far posterior chaetigers and flat dorsal shield as opposed to with depression. While neurohooks of the new species are present from chaetiger 8, the neurohooks of *Daylithos iris* are present from chaetiger 10; *D. japonicus* is from chaetiger 8; and *D. amamiensis* is from chaetiger 7. Eyes present in the new species, while absent in *D. iris*. Anterior row of body papillae in *D. langkawiensis* sp. nov. are shorter than posterior ones; in *D. amamiensis* sp. nov., are longer than posterior ones; anterior ones in *D. japonicus* and the new species are similar in size to posterior rows; 5–8 neurohooks present in posterior chaetigers of *D. japonicus*, while 2–6 neurohooks in posterior chaetigers of *D. langkawiensis*.

## Discussion

Members of *Daylithos* from Japan were previously known only by *D. parmatus* (Fauvel 1936; Imajima and Hartman 1964; Uchida 1992), but this study has revealed the presence of three different species. The Japanese “*D. parmatus*” was first reported by Fauvel (1936). The Japanese name ‘Minami-habouki’ was given to Japanese *D. parmatus* by Iwase et al. (1990). Since then, the Japanese species continued to be regarded as *D. parmatus* (= Minami-habouki) without detailed description (Uchida 1992; Imajima 2006). The first record of Fauvel (1936) is based on specimens from the area around the Seto Marine Biological Station (Kyoto University) in Wakayama and the paratype specimens of *D. japonicus* sp. nov. from this study were also from the Seto Marine Biological Station area. It is, therefore, reasonable to assign *D. japonicus* to the species previously treated as ‘Minami-habouki’ in Japan.

Japanese “*Daylithos parmatus*” was previously thought to live in burrows within rocks and corals. Now they have been divided into three species, two of which bore into corals (*D. japonicus* sp. nov. and *D. amamiensis* sp. nov.) and one of which bores into rocks (*D. sugashimaensis* sp. nov.). Other burrowing polychaetes are known to have both physical and chemical perforations (Hutchings 2008, 2011). As chemical penetration is thought to be present in Spionidae (Simkiss and Tyler 1957; Dorsett 1961; Sato-Okoshi and Okoshi 2000), it is possible that this is also present in Flabelligeridae. If chemical penetration is used, there may be some differences in chemical composition amongst the three species. *D. japonicus* come from a variety of coral species rather than from a specific coral. This indicates that *D. japonicus* may have a chemical composition that is compatible with various hardness and types of corals.



## Key to species of *Daylithos* (modified from Salazar-Vallejo (2012))

- 1 Body blackish..... *D. cinctus* (Haswell, 1892)
- Body greyish or pale..... 2
- 3 Dorsal shield with a middorsal longitudinal depression ..... *D. parmatus* (Grube, 1877)
- Dorsal shield flat..... 4
- 4 Body papillae single row ..... *D. amorae* Salazar-Vallejo, 2012
- Body papillae two rows..... 5
- 5 First falcate neurohooks in chaetiger 7 or 8 ..... 6
- First falcate neurohooks in chaetiger 6, 9, or 10 ..... 9
- 6 Dorsal shield with posterior triangular projection ..... *D. dieteri* Salazar-Vallejo, 2012
- Dorsal shield without posterior triangular projection ..... 7
- 7 First falcate neurohooks in chaetiger 8 ..... 8
- First falcate neurohooks in chaetiger 7 ..... *D. amamiensis* sp. nov.
- 8 Far posterior chaetigers with 5–8 neurohooks ..... *D. japonicus* sp. nov.
- Far posterior chaetigers with 2–6 neurohooks ..... *D. langkawiensis* sp. nov.
- 9 Dorsal shield with dorsal posterior projection; first neurohooks from chaetiger 6..... *D. nudus* (Caullery, 1944)
- Dorsal shield without dorsal posterior projection; first neurohooks from other chaetiger..... 10
- 10 Far posterior chaetigers with 2–4 neurohooks ..... *D. sugashimaensis* sp. nov.
- Far posterior chaetigers with 5–8 neurohooks ..... *D. iris* (Michaelsen, 1892)

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## References

- Amor A (1994) Ecology of *Pherusa* sp. (Polychaeta, Flabelligeridae). In: Dauvin JC, Laubier L, Reish DJ (Eds) Actes de la 4ème Conférence Internationale des Polychètes. Mémoires du Muséum National d'Histoire Naturelle, Paris 162: 339–346.
- Dorsett DA (1961) The behaviour of *Polydora ciliata* (Johnst.). Tube building and burrowing. Journal of the Marine Biological Association of the United Kingdom 56(3): 649–674. <https://doi.org/10.1017/S0025315400016167>
- Fauvel P (1936) Annélides Polychaètes du Japon. Mémoires of the College of Science Kyoto Imperial University, Series B 7: 41–92.
- Hayashi I, Miura T, Horikoshi M (1982) Preliminary study of the sublittoral benthic community on rocky bottom in Otsuchi Bay. Otsuchi Marine Research Center Reports 8: 1–6.
- Hutchings P (2008) Role of polychaetes in bioerosion of coral substrates. In: Wisshak M, Tapanila L (Eds) Current Developments in Bioerosion. Erlangen Earth Conference Series, Springer, Berlin. [https://doi.org/10.1007/978-3-540-77598-0\\_13](https://doi.org/10.1007/978-3-540-77598-0_13)
- Hutchings P (2011) Bioerosion. In: Hopley D (Eds) Encyclopedia of Modern Coral Reefs. Encyclopedia of Earth Sciences Series. Springer, Dordrecht. [https://doi.org/10.1007/978-90-481-2639-2\\_5](https://doi.org/10.1007/978-90-481-2639-2_5)
- Imajima M (1982) Polychaetous annelids around Shimoda, Izu Peninsula. Memoirs of the National Science Museum, Tokyo, 159–183. [In Japanese with English abstract]
- Imajima M (2006) Polychaetous annelids from Sagami Bay and the Sagami Sea, central Japan. Memoirs of the National Science Museum 40: 317–408.
- Imajima M (2011) Polychaetous annelids collected from Sagami Bay toward the Ogasawara islands, Japan. Memoirs of the National Museum of the Natural Science 47: 145–218.
- Imajima M, Hartman O (1964) The polychaetous annelids of Japan. Part II. Allan Hancock Foundation Publications Occasional Paper 26: 239–452.
- Iwase F, Uchida H, Nomura K, Fukuda T, Misaki H (1990) Okinawa Kaichu Seibutsu Zukan [Illustrated Guide to Marine Life in Okinawa], Shinsei Zukan Series (Vol. 11). Sazan Press, Okinawa, 258 pp. [in Japanese]
- Jimi N (2020) Diversity of Flabelligeridae. Umiushi Tsushin 103: 2–4. [In Japanese]
- Jimi N, Hookabe N, Moritaki T, Kimura T, Imura S (2021) First evidence of male dwarfism in scale worms: A new species of Polynoidae (Annelida) from hermit crab and molluscan shells. Journal of Zoological Systematics and Evolutionary Research 59(4): 801–818. <https://doi.org/10.1111/jzs.12463>
- Michaelsen W (1892) Polychaeten von Ceylon. Jahrbuch der Hamburgischen Wissenschaftlichen Anstalten 9: 1–23.
- Salazar-Vallejo SI (2012) Revision of *Semiodera* Chamberlin, 1919 (Polychaeta: Flabelligeridae). Zootaxa 3562(1): 1–62. <https://doi.org/10.11646/zootaxa.3562.1.1>



- 
- Salazar-Vallejo SI (2019) Flabelligeridae Saint-Joseph, 1894. In: Purschke G, Böggemann M, Westheide W (Eds) Handbook of Zoology: Annelida, 1. Annelida Basal Groups and Pleistoannelida, Sedentaria, DeGruyter, Berlin, 480 pp.
- Sato-Okoshi W, Okoshi K (2000) Structural characteristics of self-excavated burrows by boring polydorid species (Polychaeta, Spionidae). Bulletin of Marine Science 67: 235–248.
- Simkiss K, Tyler C (1957) A histochemical study of the organic matrix of hen egg shells. The Quarterly Journal of Microscopical Science 98: 19–28. <https://doi.org/10.1242/jcs.s3-98.41.19>
- Uchida H (1992) Annelida, Polychaeta. In: Nishimura S (Ed.) Guide to seashore animals of Japan with color pictures and keys (Vol. 1), 310–373. [In Japanese]
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